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ABSTRACT

Briefly presented are the rationale and procedures used to develop and validate an interactive videodisc program to assist in diagnosing difficulties in mathematics in grades 1-3. The mathematics assessment program is described as 408 criterion-referenced items divided into seven strands. Questions are administered until a student makes three consecutive errors; then the student is branched to the next section in a strand. At the teacher's option, the test can be administered in either English or Spanish. Information is also included on equipment configurations possible among videodisc players, microcomputers, touch screens, and printers, and disc capacity is noted. Finally, comments on formative evaluation needs are given. (MNS)

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THE APPLICATION OF VIDEODISC TECHNOLOGY
TO THE DIAGNOSIS OF MATH SKILLS

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Abstract

The paper describes the rationale and procedures used to develop and validate a videodisc to assist in the diagnosis of math skills.

The disc focuses on math skills taught in the first three grades. Each skill can be presented in English or Spanish. The disc has been designed to assess competencies and commonly-made errors. Descriptions of the different equipment configurations possible among videodisc players, microcomputers, touch screens, and printers are included. The math disc was designed to be compatible with most of the math textbooks.

THE APPLICATION OF VIDEODISC TECHNOLOGY TO THE DIAGNOSIS OF MATH SKILLS

Objectives and Rational

The major objective of the interactive videodisc for Special Education Technology (IVSET) project is to develop and validate an interactive videodisc program to help diagnose specific math problems in the achievement range K-3 for both English and Spanish speaking students.

The basic rationale for the project results from the need to conduct research on alternatives to the more traditional diagnostic testing procedures. Some of the common problems associated with this type of testing include:

1. The difficulty of discriminating between language skills and math skills when the student's most proficient language is not English.
2. The difficulty of discriminating between reading skills and math skills when using a written math assessment instrument.
3. The need for assessment systems to respond to individual patterns of test performance.
4. The difficulty of managing large numbers of specific objectives. This problem is most acute with criterion referenced assessment.
5. The need for a means to administer assessments that are consistent across assessment environments.

The IVSET Math Assessment Program

The IVSET Math Assessment Program is designed to be a criterion referenced measure of the math skills of students whose math achievement range lies between grades 1 and 3. At the teacher's option the test can be administered in either English or Spanish. The use of the videodisc allows this because two audio tracks are available for each section of video. This allows Hispanic students, whose primary language is not English, to take the test in his/her primary language.

The IVSET Math Assessment Program provides a unique testing environment. Students are not required to have reading skills as the test is administered orally, thus reducing the impact of reading ability on test performance. This is especially important in the case of learning disabled populations where there may be wide discrepancies between reading and mathematical ability. Since it is criterion referenced, it provides a profile of student's mastery of skills instead of a grade equivalent score. This allows the user to focus instruction or remediation on specific problems identified from the assessment.

Two equivalent forms of the test contain 408 criterion referenced items each. These items consist of a graphic and an audio segment. All of the questions are of the multiple choice or true/false variety. No constructed responses are required. The test is divided into seven "strands". Each strand covers a mathematical concept or skill area. Problems in each strand are presented in ascending order of difficulty. Each strand is further divided into "Sections". Sections contain subgroups of skills within each strand. Management of this large number of items is possible because the computer controls the presentation of the items, branching to different strands and the collection of data. The student's progress is monitored by the computer throughout the assessment process.

When the test is administered, students start with the first question in the first section of a strand. Teachers can select any strand to begin the assessment. Test questions in a section are administered until a student makes three consecutive errors. When a student misses three consecutive questions the student is then branched to the next section in the strand. When all sections in a strand have been completed in this manner, the next strand is presented or the program branches back to a menu.

Teachers have two methods of administering the test. If the teacher desires to give a complete assessment and test every area, the system will automatically administer the entire test (and even call the teacher when it is time to turn over the disc). If a teacher only wished to check a particular area, the system allows the user to select the particular strand and section desired, administer it and return to a main menu. The system can also be exited at any time by the student or teacher.

Equipment Configurations

The IVSET Math Assessment Program uses two separate systems to deliver the test. These are referred to as the "Full System" and the "Stand Alone" system. These systems both use the same disc but differ in the equipment configuration.

The Full System (See Figure 1) consists of a Pioneer Model 7820-III Videodisc player, an Apple II Plus microcomputer with two $\frac{5}{4}$ " floppy disc drives, a SONY 12" color monitor and a Carroll Mgf, touch panel built into the monitor. The videodisc player was selected for its rapid, random access capabilities and excellent still frame quality. (A typical search and retrieval of an instruction or feedback segment takes less than 1 second). The touch panel is a light interrupt system that allows the student to interact with the system simply by touching the monitor screen. The Apple II controls the system through computer programs and an interface device (Allen VMI Board). Both were designed and developed by IVSET Program staff. The videodisc is the storage medium. It has the approximate size and appearance of an LP phonograph record and is capable of storing 54,000 individual frames of video or 30 minutes of audio and motion video on each side. It also has two independent audio tracks.

The Full System is designed to automatically track student progress through the test, record responses, provide for report generation of student results, process information and do error analysis of students incorrect responses. Error analysis is performed upon selected questions which involve computation by the student. Some of the multiple choice distractors used by the teacher were constructed to represent a particular computation error. The teacher uses this to diagnose a pattern of errors. The computer automatically records the number of errors of any particular error type and the number of times the student could have made the error. This allows the teacher to determine whether multiple errors of the same type were coincidental or representative of a pattern. For example, a student who made an error each time s/he was exposed to it as an option may have a computation problem. But a student who made the error twice with twelve chances to make it probably represents chance.

The Stand Alone System (See Figure 2) uses only a videodisc player, monitor, and printer. Test presentation is identical in both systems. The Stand Alone System uses the Remote Control Unit to enter student responses. It uses the built in microprocessor in the videodisc player to control the test administration. The programs that control the player are contained on the disc itself. These programs are read by the player and allow the Stand Alone System to continually reprogram itself. The Stand Alone System also allows the user to obtain a print-out of test results if desired.

Disc Capacity

At the current state of videodisc technology, a disc will store the video for 108,000 still frames or 1 hour of video motion and associated audio. With the IVSET math assessment system the video can always be represented with one still frame, however, since spoken instructions are used with each item of the assessment, audio is required. Audio requires 30 frames per second which translates into the 1 hour capacity. Working with these constraints, we were able to store 15 minutes of training material and 408 items on one disc. On the average, each item used approximately $6\frac{1}{2}$ seconds of video disc space. If the pupil and teacher training information was not put on the disc, approximately 550 items of the type used in the IVSET Math Assessment could be stored on one video disc. In the near future (within 2 years) compressed audio will be available with videodisc systems. The projection is that 7 seconds of audio will be available with each frame. At this ratio 210 hours of audio or 108,000 assessment items of the type used in the IVSET Math Assessment program, could be stored on one videodisc.

Formative Evaluation

One of the problems encountered in the production of videodisc programs is in inability to formatively assess the program prior to the mastering of a disc. This problem arises because the disc is a read-only device. That is, once a disc is produced (mastered) it cannot be changed. Since videodisc mastering is relatively expensive, (\$2500.00 per side), it is desirable to conduct formative evaluations

before the disc is mastered. The best means available at present is the use of random access videotape systems. These can simulate some but certainly not all of the characteristics of a videodisc. While microcomputer controlled interface cards are available for both the videodisc and random access videotape, an interface card did not exist that would allow one to use the same software easily with both videotape and videodisc. As a part of this project we developed a single interface board that will work with most of the random access videotape systems as well as the more common videodisc systems. This card has been designed for an Apple II microcomputer and will be used in preliminary field testing of the system in April 1983. After revisions, the videodisc will be produced and field tested in the Fall of 1983.

To date the following R&D objectives have been achieved:

1. Item content has been identified, prototype video tapes have been developed, expert reviews of tapes have been completed and field testing with pupils is in progress.
2. An interface board to facilitate both the formative evaluation with video tape and the final operation with videodisc has been developed and field tested in wirewrap form.
3. An interface program has been developed to drive a printer from a videodisc without the use of a separate microcomputer.
4. A simulation program has been developed that would allow for the formative evaluation of digital dumps to control the videodisc and printer.
5. An authoring system has been developed that will allow for the development of both criterion referenced assessment instruments and tutorial programs capable of handling the videodisc, touchscreen, keyboard, microcomputer and printer.

FULL VIDEODISC SYSTEM FOR MATH ASSESSMENT

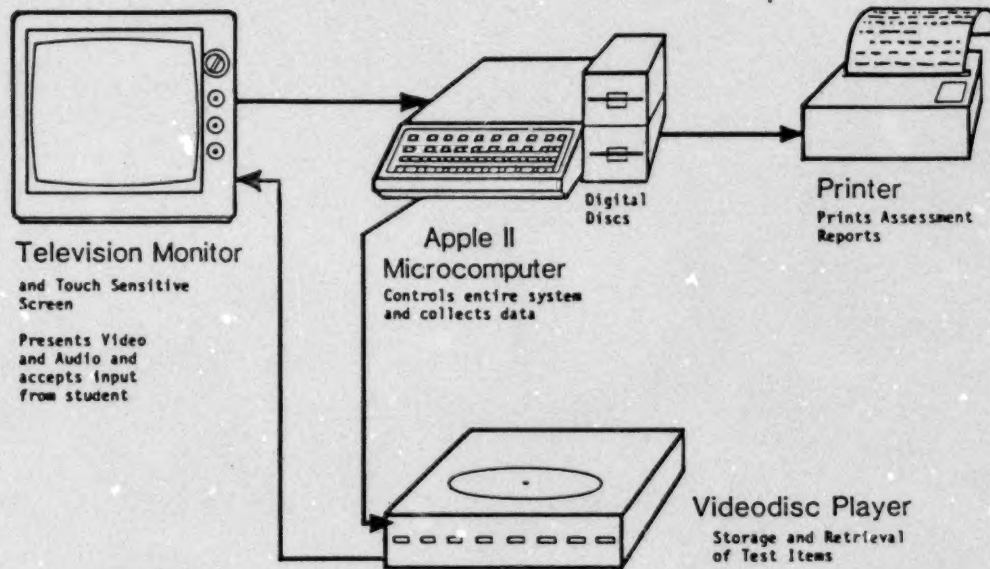


Figure 1

STAND ALONE VIDEODISC SYSTEM FOR MATH ASSESSMENT

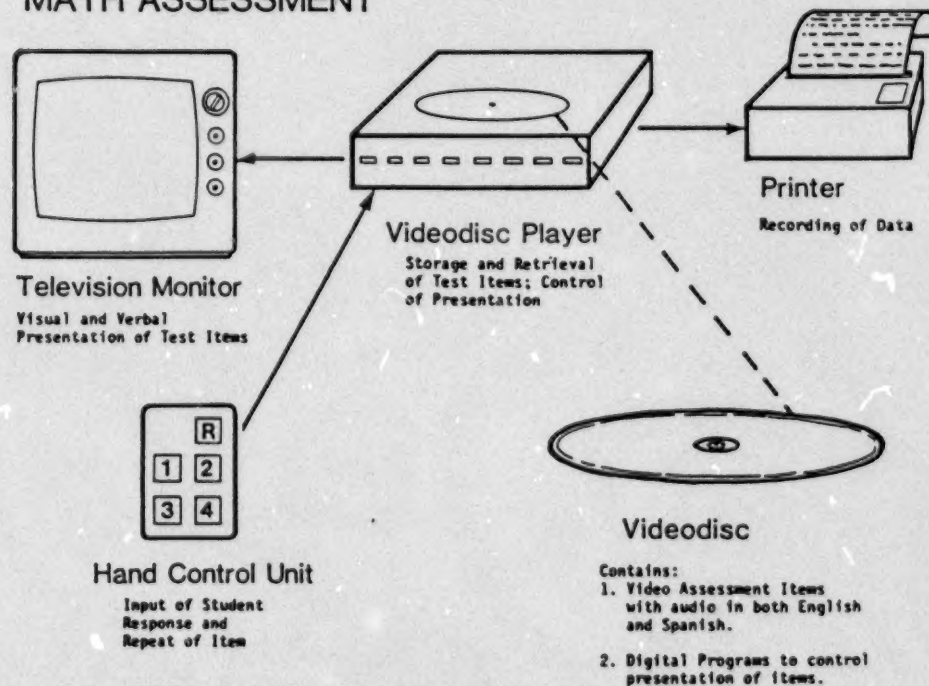


Figure 2